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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication Progress Paces Ball and Roller Bearing Developments

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

BALL AND ROLLER BEARING LUBRICATION

THE ABEC* GREASE STANDARD

ABEC—I. (Type of Grease recommended for speeds and temperatures as indicated in Guide for Relubricating Ball Bearings. See inside back cover.)

Greases shall be free from dirt, abrasive matter, fillers, excessive amounts of moisture and free acid or free alkali.

Nature of soap	Soda or soda lime; maximum lime soap 5% of total weight of grease; uncombined lime 0.10% max.
Worked Penetration, ASTM	190 min.
Running Torque, ABEC Test	60-300 gm. cm.
Leakage:	
Thru plate seal	5% max.
Left in bearing	75% min.
Oxidation	(See details below)

ABEC—II. (General purpose greases, suitable for grease gun applications, for modern speeds and temperatures as indicated in Guide for Relubricating Ball Bearings. See inside back cover.)

Nature of soap	Soda or soda lime; maximum lime soap 5% of total weight of grease; uncombined lime 0.10% max.
Worked Penetration, ASTM	260 min.
Running Torque, ABEC Test	60-450 gm. cm.
Leakage:	
Thru plate seal	20% max.
Left in bearing	75% min.
Oxidation	(See details below)

CLEANLINESS

Greases shall be free from dirt, abrasive matter, fillers, excessive amounts of moisture and free acid or free alkali.

OXIDATION RESISTANCE

Greases shall show no evidence of deterioration following 18 months storage in bearings in individual sealed boxes or packages as indicated by oil leakage, hardening, or gum formation of the grease, or by loss of free turning by hand.

Alternatively, the grease shall show not more than 5 lbs. drop in oxygen pressure following a 100-hour run in Norma-Hoffmann oxidation bomb at 210° F. and 110 lbs. initial oxygen pressure, using a 20-gram sample on standard glass sample dishes.

*Annular Bearing Engineers Committee

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication Progress Paces Ball and Roller Bearing Developments

THE importance of the ball and roller bearing industry was brought into the lime-light when intensive bombing of enemy bearing plants was publicized as one of the principal ways of shortening the war. For years ball and roller-bearings had been accepted as *essential* — everybody knew their car had a lot of them but only the engineer or the inquisitive layman who read his instruction book knew their location.

It took a war to impress upon us that this is a *vital* industry. Without it, air power and mechanized warfare would be impossible. Without it, our unbelievable records of production, both on consumer goods as well as war material, could never have been made.

Ironically, the earliest record of the use of rollers to reduce friction came about as a result of war. In 680 B.C., the slaves of King Sennacherib of the Assyrians — in reality, his prisoners of war — placed log rollers under the stone monuments which were dragged to adorn his palace.

Picture in contrast the modern bomber with some 1500 ball bearings on its controls; the heavy duty roller bearings worth hundreds of dollars each in the modern paper machine and steel rolling mill; the multitude of minute ball bearings in a bomb-sight; the spindle bearings on certain grinding machines turning around 40,000 r.p.m. No wonder the production of hundreds of millions of ball and roller bearings annually is a vital industry.

TRENDS IN BALL AND ROLLER BEARING LUBRICATION

1. **High Speeds.**
2. **Sealed Bearings.**
3. **Wider Speed Limits.**
4. **Controlled Lubrication.**
5. **All-temperature Greases.**
6. **Wider Temperature Ranges.**
7. **Prepacked Grease Lubrication.**
8. **Greater use of Precision Bearings.**
9. **Use of Spray or Oil-Mist Lubrication on High Speed Oil-Sealed Bearings.**
10. **Rust and Oxidation Resistant Lubrication.**
11. **Means for Re-lubricating Sealed Bearings.**

The ball and roller bearing industry certainly has made progress. The petroleum industry kept pace with these trends.

During the transition of the ball and roller bearing through the ages, from the log rollers of the Assyrians and the laboratory inventions of Leonardo da Vinci down to the more modern applications of Hyatt and Stribeck, load, speed, and temperature conditions became definite factors.

When the ball and roller bearing developed into a vital part in machine design, lubrication also required consideration. The turn of the century saw this type of bearing coming into its own, along with the automotive vehicle. World War I saw a definite expansion of our facilities for manufacturing when exports from Europe

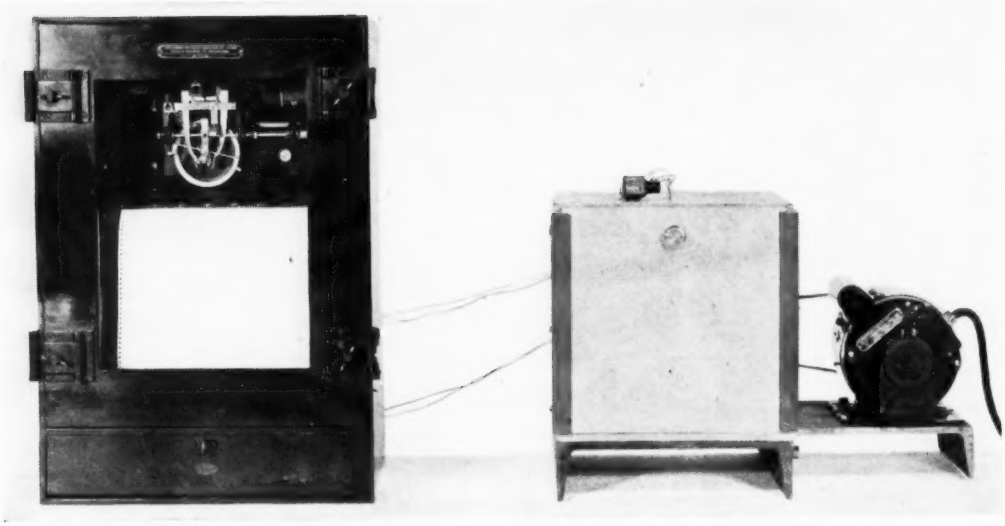


Figure 1—The high speed grease endurance apparatus assembled.

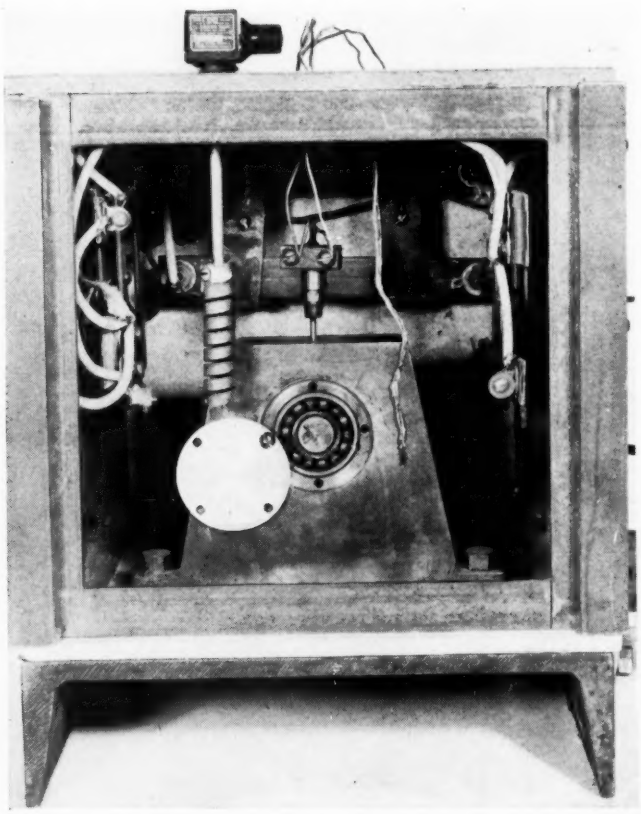


Figure 2—Showing the test bearing within the high speed grease endurance apparatus.

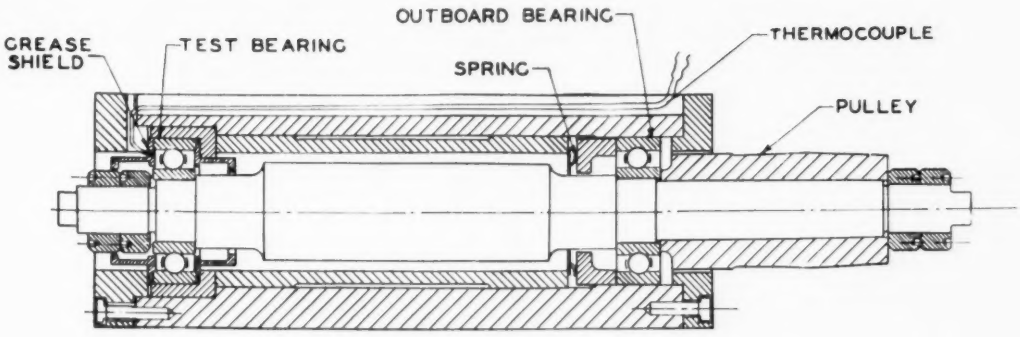


Figure 3—Showing the test spindle and bearings.

were curtailed; World War II has sponsored this bearing as a precision mechanism to a position comparable with 100 octane gasoline, T.N.T., and synthetic rubber. It is definitely non-expendable.

COOPERATIVE RESEARCH

Military requirements have led to better coordination of research between the ball and roller bearing and the petroleum industries than ever before. It is true that with the organization of the Annular Bearing Engineers Committee and the National Lubricating Grease Institute, laboratory activities were expanded several years before the war and new products were developed. But it took stratosphere flying, the precision bomb sight, and the tank to drive home the fact that millions of the ball and roller bearings required annually to wage war had to be *precision* mechanisms. Furthermore, stratosphere flying below −60° Fahr.* impressed upon all concerned that conventional ball bearing greases wouldn't do. Special greases had to be developed which would be so "workable" at these temperatures as to permit free rolling of the bearing elements, otherwise, proper control of the plane could not be maintained.

So the laboratories of the petroleum and bearing industries went to work. The proof of their findings is evidenced by the flexibility of our air power today, the accuracy of our bombings, the maneuverability and speed of our armed forces. Bearings and lubrication furnished the connecting link between engine power and fire power.

*The lowest temperature to which reference has been made is −110° Fahr.

Just how the research people in the bearing and petroleum industries have worked is of interest. The former, of course, contributed the necessary designs, decided upon the types of steels, planned the production schedules to include precision finishing, worked out more thorough types of seals, and invented ways to relubricate the pre-packed bearing.

The petroleum chemist in turn studied the low temperature characteristics of the available fats and mineral oils, perfected methods of compounding in order to retain or improve these characteristics; and then, in conjunction with the research workers of the ball and roller bearing industry, adopted methods of testing which would be comparable with actual service conditions as to temperature, speed, load, exposure to moisture. Resistance to oxidation and rust prevention were definitely improved in this way.

Resistance to Oxidation

Referred to at times as stability, the resistance which a ball or roller bearing lubricant shows to oxidation is an important economic characteristic. It does little good for a grease to be able to function from −40° F. to +250° F. or for an oil to meet all the prescribed physical tests, if either is susceptible to rapid oxidation. The resultant gums and lacquers will very soon interfere with free rolling of the bearing parts. Then, as oxidation progresses, the corrosive tendency also may increase.

When the petroleum chemist realized that resistance to oxidation went beyond the questions of the selection of the base oil and its subsequent refinement or compounding, he looked around for

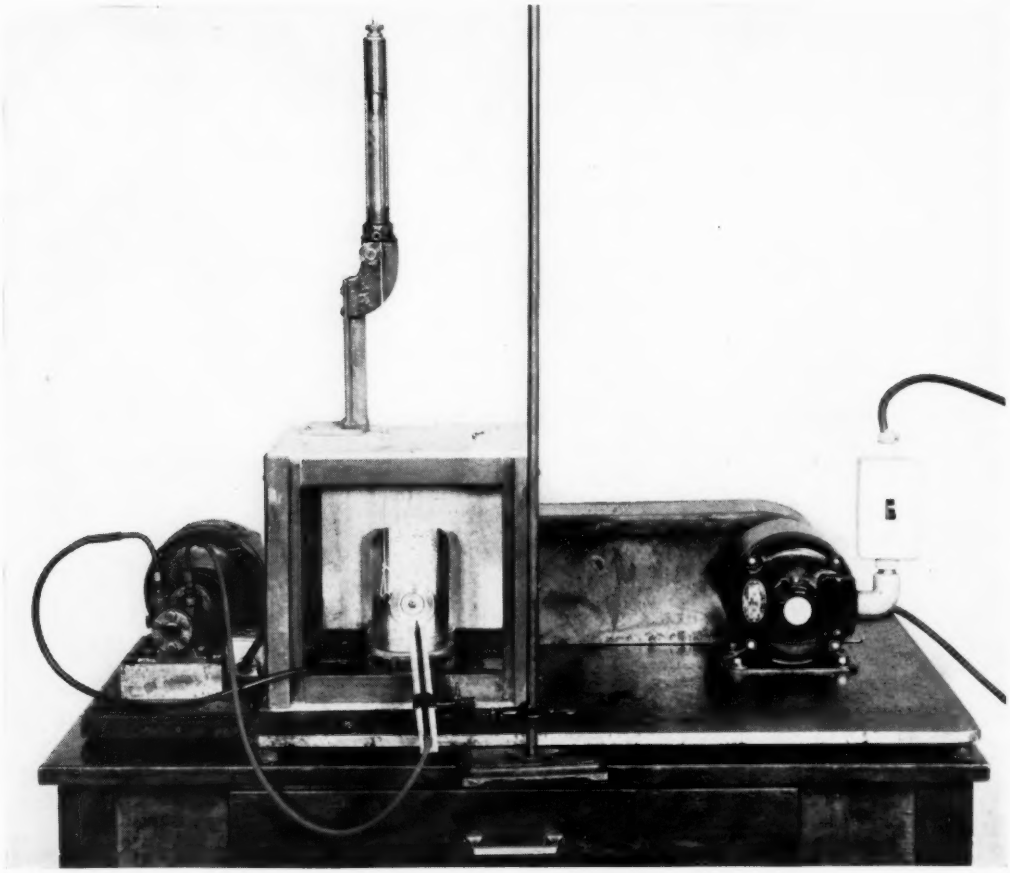


Figure 4—Showing assembly of the water resistance test apparatus.

oxidation inhibitors. A wide variety was available. It remained to segregate these and work with the most promising, using actual combinations with lubricating oils and greases and testing under service conditions in the laboratory, then in the field.

Rust Resistance

Equally as important, especially under high moisture conditions, is the ability of a ball or roller bearing lubricant to prevent rusting. Basically, it requires a lubricating film which will more readily wet a steel surface than will moisture and, having exerted this preferential wetting, the film must stick tenaciously and resist any subsequent washing off effect of water.

Research has been very active of late in developing greases which will satisfactorily resist salt water rusting. Such greases are especially valuable in protecting the ball bearings of naval aircraft which are exposed to salt water spray and the resulting corrosive or rusting effects.

LABORATORY ENDURANCE TESTS AT HIGH TEMPERATURES AND HIGH SPEEDS

The factor of successful long-time operation in the temperature range to be encountered is the only valid criterion of lubricant performance. Short-time screening tests on bearings at various temperatures may indicate poor lubricants; they are of value in giving an indication of texture changes, breakdown, and leakage of unknown greases. The results however, must be interpreted with caution and treated as preliminary data subject to confirmation by endurance tests such as those to be described. This method of procedure has been very successful in cooperative work between lubricant manufacturers and anti-friction bearing manufacturers in developing outstanding premium ball and roller bearing greases.

High Speed Grease Endurance Test

A test has been developed by the Army-Navy

Aeronautical Board to insure satisfactory operation of critically-important accessories. This test involves running bearings at 10,000 r.p.m., and 300° F. The grease under test must lubricate successfully for at least 300 hours under the conditions specified.

Figures 1 and 2 show the High Speed Grease Endurance Apparatus as set up at the Beacon, New York, Research Laboratory of The Texas Company. As specified, the test is run at 300° F. for 22 out of each 24 hours, with daily starts at room temperature. Failure is measured in a very practical way by failure of the motor to start the spindle when the test bearing seizes. Excessive leakage is undesirable.

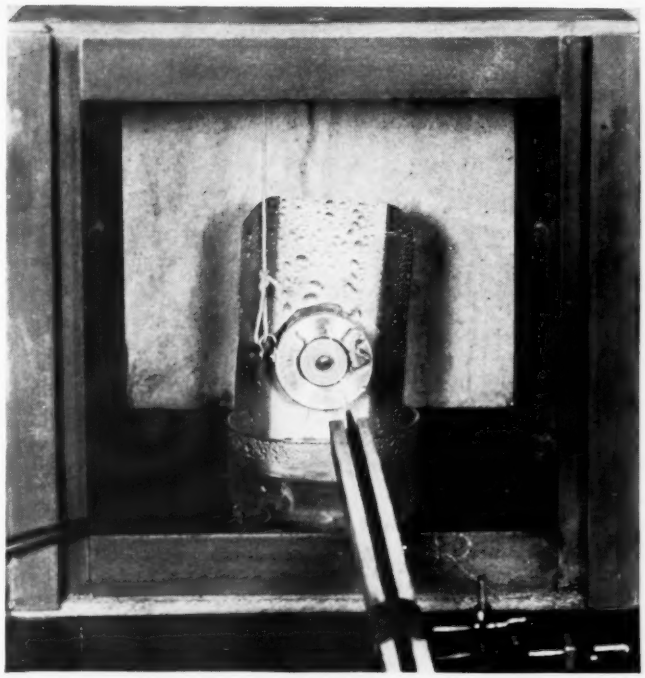


Figure 5—Close-up of the water resistance test apparatus showing water jet impinging on the bearing.

ABEC-NLGI Test

The ABEC*-NLGI* Sub-Group on Grease Performance Tests at Elevated Temperatures are at present developing a 10,000 r.p.m. high temperature bearing test which is similar in principle to the above mentioned test, but differs in imparting a five-pound thrust load to the test bearing and in certain constructional features as shown in Figure 3, which illustrates details of the test spindle and bearings.

A comprehensive program of cooperative testing is now underway on the above equipment. The Texas Company is one of the cooperating partners in this endeavor.

Future Trends in Military Specifications

The trend to performance specifications for lubricating greases, rather than composition specifications built around specific products, is well brought out by Britton and Schlesinger of the Air Technical Service Command, Wright Field, in the following quotations.**

> "The 'performance-mindedness' of the services has changed to some extent the mode of writing specifications. Previously specifications were frequently written by ascertaining which of a group of products satisfactorily lubricated a piece of equipment and establishing a series of chemical

*ABEC — Annular Bearing Engineers Committee
NLGI — National Lubricating Grease Institute.

**From page 7 of preprint of the paper "Military Aircraft Grease Lubriation" Major S. C. Britton and W. Schlesinger, Materials Lab., ATSC, Wright Field, presented at the National Fuels and Lubricants Meeting, SAE, November, 1944.

Figure 6—Bearings after being subjected to one hour treatment in the water resistance test. 100 per cent grease loss developed in the bearing at the left, using a product with unsatisfactory water resistance. Only 20 per cent grease loss developed in the bearing at the right, using a satisfactory water-resistant grease.

Types of Anti-friction Bearings

Ball Bearings

*4. Duplex bearings are specially face ground for use in pairs.

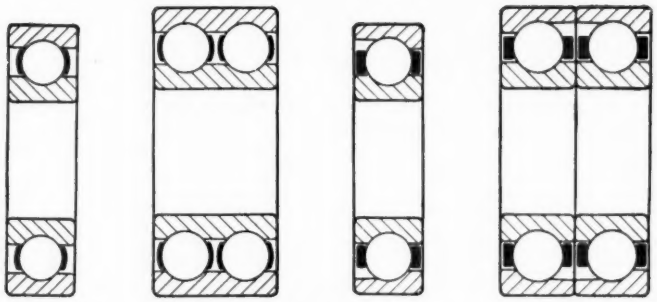
*5. Snap Ring bearings are used both with and without shields.

*6. Shields may be on either one or both sides.

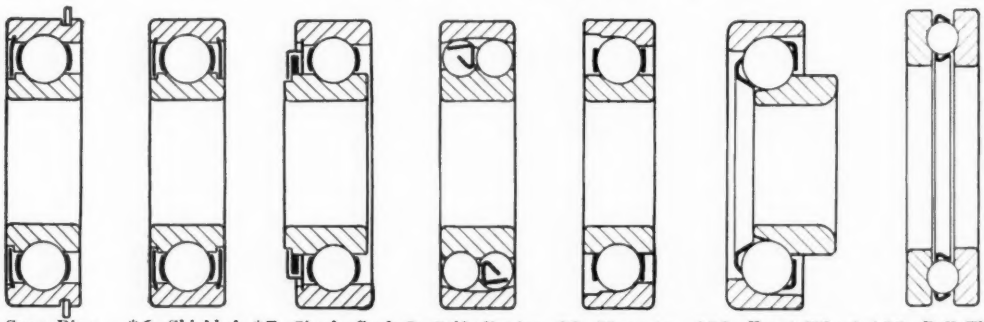
*7. Sealed bearings may have seals on both sides—are then wider.

*9 & 10. Magneto and Front Wheel bearings are separable.

*11. Ball Thrust bearings are treated separately on pages 16 and 17.



1. Single Row 2. Double Row 3. Radial-Thrust *4. Duplex



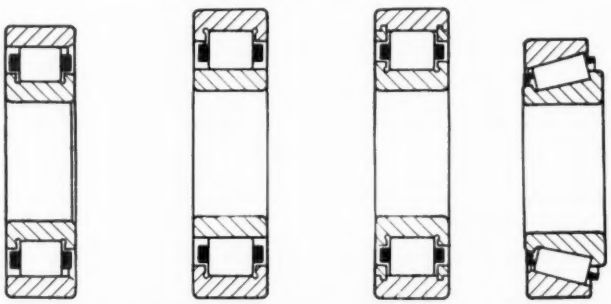
*5. Snap Ring *6. Shielded *7. Single Seal 8. Self-aligning *9. Magneto *10. Front Wheel *11. Ball Thrust

Roller Bearings

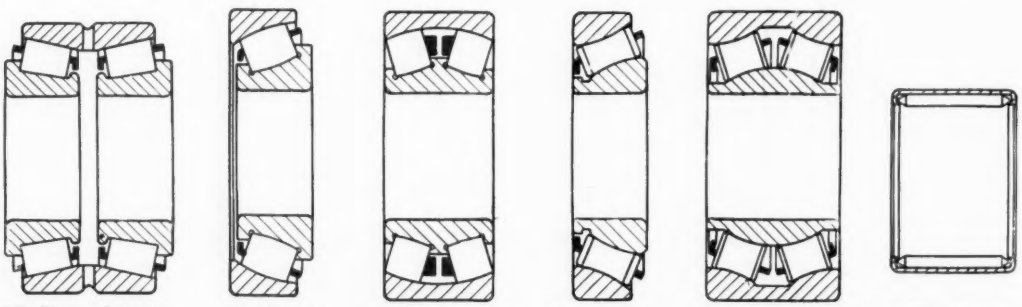
*1, 2, 4, 5, 6, & 8. These bearings are all separable either as to inner or outer rings.

*5. Double Row tapered roller, adjustable through cones. Also made adjustable through the cups.

*10. In some cases needle bearings may have inner rings which are separable.



*1. Straight Roller Separable outer ring *2. Straight Roller Separable inner ring 3. Straight Roller Non-separable *4. Tapered Roller



*5. Tapered Roller Double Row *6. Barrel Roller 7. Barrel Roller Double Row *8. Concave Roller 9. Concave Roller Double Row *10. Needle Roller

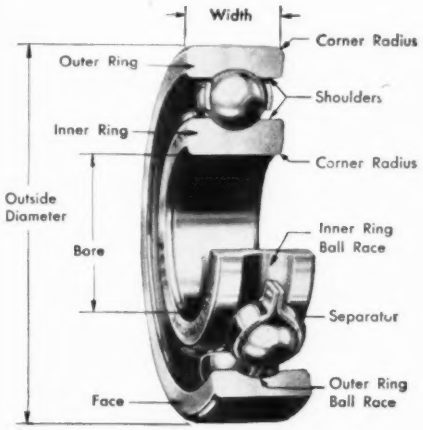
Courtesy of Anti-Friction Bearing Manufacturers Assoc., Inc.

Bearing Parts and Their Names

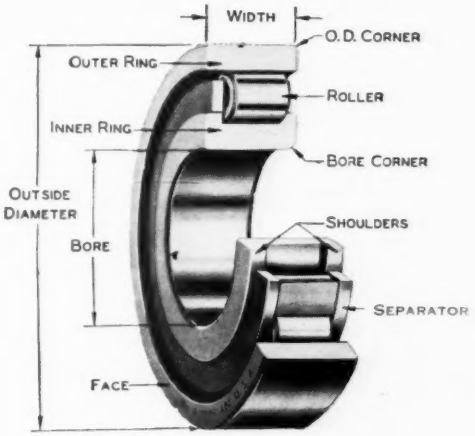
The parts common to all standard ball and roller bearings have, for the purpose of this manual, been given names as shown below.

Basically all anti-friction bearings consist of two hardened steel rings, the hardened balls or rollers and separator. A number of variations of these types are in use. Some types, such as Needle roller bearings may be used without an inner ring, the rollers fitting directly upon the hardened shaft. Needle bearings have no separator.

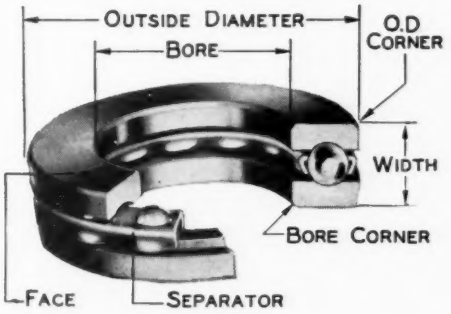
Ball Bearing



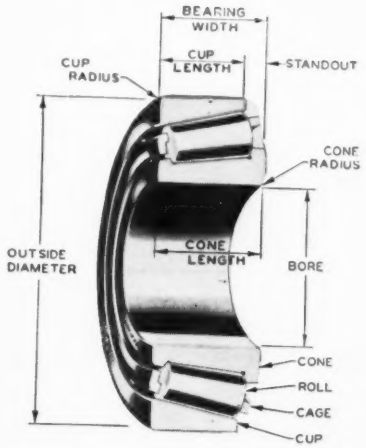
Straight Roller Bearing



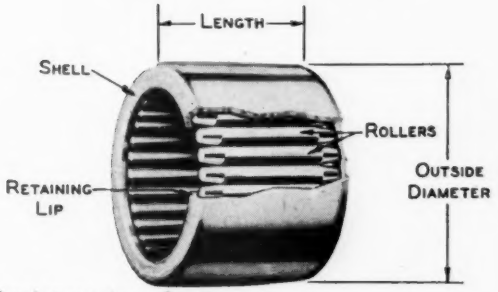
Ball Thrust Bearing



Tapered Roller Bearing



Needle Roller Bearing



Courtesy of Anti-Friction Bearing Manufacturers Assoc., Inc.

and physical controls which described products as nearly as possible like the best greases tested. The tendency now is to determine what the limiting performance factors are for each new piece of equipment and to select from existing specifications one which will satisfactorily perform the task required. This means that military grease specifications must overlap sufficiently in their performance ranges and types to take care of any eventuality in new designs. If there is no such specification, an existing specification may be modified or a new specification written based on limiting characteristics such as torque, shear, operating temperature, etc. of the equipment itself. The generalized service performance demands, and not the specific functioning of a particular grease in a particular piece of equipment determine how specifications are to be written."

The foregoing represents a laudable development in many ways. Not only does it insure a supply of proven lubricants for critical military applications, but it frees the grease manufacturer from the limitations of specified composition and encourages initiative and ingenuity in developing formulas to solve the problems of temperatures, speeds, torques, loads, etc. to be met. The beneficial results of such an approach are being continually shown in the present emergency by the creation through research of lubricants far exceeding original objectives, thus enabling designers of equipment to raise their sights in turn.

Water Resistance of Greases

The determination of the water resistance of greases has been the subject of much study, and widely-varying tests have been used by different organizations.

For this purpose a dynamic test* has been developed in which a jet or spray of water is impinged upon the face of a shielded 204 bearing revolving at 600 r.p.m. There is sufficient clearance between the shield and the inner ring for water to work into the bearing. The test is continued for one hour. Water-susceptible greases wash out substantially completely at the end of this period, whereas water-resistant greases retain the majority of the grease charge on the bearing.

Figures 4, 5 and 6, pages 16 and 17, show views of this test as set up at the Beacon, New York, Research Laboratory of The Texas Company, together with a picture of two bearings after the test, one having been charged with a water-susceptible grease and one with a water-resistant grease. The difference in grease retention is rather striking.

The factor of resistance to water washing is only one aspect of water resistance and requires both severe moisture conditions and a relatively unprotected bearing to make it significant. Irwin and Britton of Wright Field have listed the following attributes as desirable in an ideal grease*:

"(a) Resist washing action of water and be adherent to the surfaces lubricated

(b) Absorb water to a limited extent without appreciable change in physical properties

(c) Inhibit corrosion"

The water resistance test appears the most promising of the available methods, since it uses an operating ball bearing and would seem capable of correlation with service under wet conditions where bearings are insufficiently shielded against moisture ingress. It represents extremely wet conditions, hence it would be too severe for wheel bearings or other such elements which may be protected by the housings.

FRICTION

Friction in a ball or roller bearing has been the subject of interesting discussion, and considerable research. The approach had to be different from the procedure which accompanied the plain or sleeve bearing, for obviously the variables differed in the ball or roller bearing. The investigators had to consider the effects of both rolling and sliding friction, also the internal or molecular friction caused by the lubricant.

Theoretically sliding friction should have the least effect upon power comsumption. Actually, in service it may be quite a factor as it depends upon the relative speeds of the rolling points. Authorities state that sliding friction is most likely to occur between the balls and retainers in deep-groove ball bearings, and in roller bearings where the rollers may have become skewed.

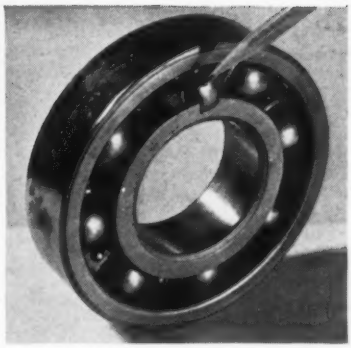
Rolling friction in turn has been found to be contingent upon the size of the balls or rollers. The smaller these elements, the higher will be the frictional resistance.

Lubrication can in part compensate for sliding friction although the resultant hydrodynamic pressure must not be overlooked. The friction due to hydrodynamic pressure, or the energy required to churn or push aside the lubricant, may be considerably higher than the normal rolling friction of the bearing elements. This phenomena is popularly called internal friction of the lubricant. That is why so much stress is placed upon the extent to which a grease may develop churning when selection is being made for many specific applications. At low loads churning may be definitely objectionable especially where power consumption is a factor as in aircraft control bearings at low temperatures, or on textile machinery or small motors.

*At the U. S. Naval Engineering Experiment Station, Annapolis, Md.

*Article "Lubricating Grease Requirements for Modern Military Aircraft" E. R. Erwin and Major S. C. Britton, ATSC, Wright Field — Presented at 1943 meeting of NLGI. National Petroleum News, Monthly Technical Section, 12-1-43, R-592.

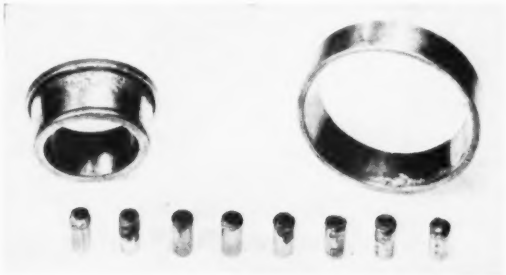
Shield bent by drift that slipped.



Broken separator often due to presence of dirt or metal chips.

Typical spalling on inner raceway of a ball bearing.

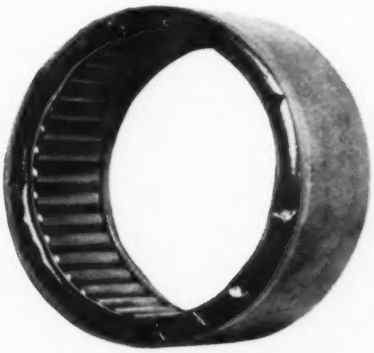
Flaked or spalled area on inner raceway of straight roller bearing.



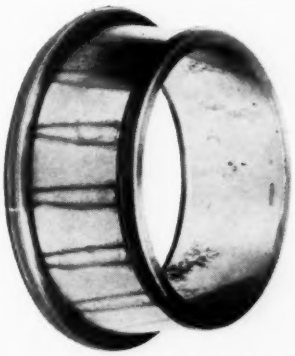
Spalled cone, cup and rollers of tapered roller bearing. Spalled bearings of any kind should never be returned to service.

Cracked Inner Ring. Often due to wrong fit or improper force during removal.

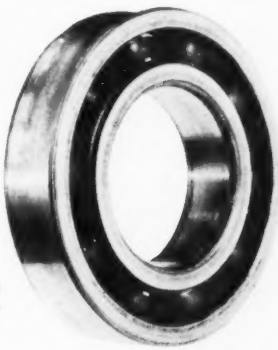
Inner raceway showing indentation or "Brinell" marks of rollers.



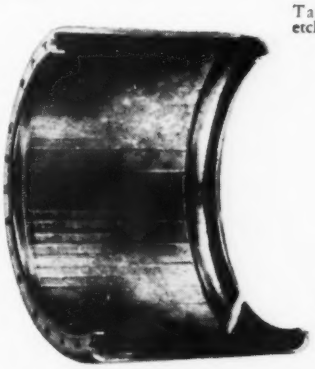
Outer race or shell dented by wrong use of hammer and chisel.



Tapered roller bearing cone etched by moisture or acid formation.



Typical discoloration caused by overheating.



Needle bearing shell indented or "Brinelled."

Courtesy of Anti-Friction Bearing Manufacturers Assoc., Inc.

SIGNS OF TROUBLE

Friction in a ball or roller bearing is expressed by a coefficient of friction or in terms of friction torque. Some authorities consider the latter as more dependable since it depends only upon the load and speed. The coefficient of friction, however, varies considerably according to the operating conditions, although correlation of the relative coefficients of friction between plain and ball or roller bearings for the same shaft size is quite practicable.

The amount of lubricant charged to the bearing also must be carefully considered. An excess can have a definite effect upon the frictional resistance, due to the hydrodynamic pressure as mentioned above. On the other hand, the manner of design and construction are definite factors. Research has shown that a precision bearing will show slightly higher friction when lubricated than when dry. This will be just the opposite in a poorly designed bearing. Higher sliding friction at the start would explain this.

The Annular Bearing Engineers Committee has issued some interesting recommendations relative to oil lubrication and the reduction of friction torque. Viz;

"The friction torque in a ball bearing lubricated with oil consists essentially of two components. One of these is a function of the bearing design and the load imposed on the bearing, and the other is a function of the viscosity and quantity of the oil and the speed of the bearing.

"It has been found that the friction torque in a bearing is lowest with a very small quantity of oil, just sufficient to form a thin film over the contacting surfaces, and that the friction will increase with greater quantity and with higher viscosity of the oil. With more oil than just enough to make a film, the friction torque will also increase with the speed.

"The energy loss in a bearing is proportional to the product of torque and speed, and this energy loss will be dissipated as heat, and cause a rise in the temperature of the bearing and its housing. This temperature rise will be checked by radiation, convection and conduction of the heat generated to an extent depending upon the construction of the housing and the influence of the surrounding atmosphere. The rise in temperature, due to operation of the bearing, will result in a decrease in viscosity of the oil, and therefore, a decrease in friction torque compared with the friction of starting, but soon a balanced condition will be reached.

"With so many factors influencing the friction torque, energy loss, and temperature rise in a bearing lubricated with oil, it is evidently not possible to give definite recommendations for selection of oil for all bearing applications, but two general considerations are dominant:

1. The desire to reduce friction to a minimum, which requires a small quantity of oil of low viscosity.
2. The desire to maintain lubrication safely without much regard for friction losses, which results in using larger quantities of oil and usually of somewhat greater viscosity in order to reduce losses from evaporation or leakage.

"This second condition is most frequently met and in view of the broad outline of lubrication with oil given above, the chart (see inside back cover) has been made up for selection of viscosities of oil for various operating conditions.

"The operating speeds (r.p.m.) are given on one coordinate of the diagram and the bearing loads in pounds on the other, both to a logarithmic scale. The lines intersecting the coordinates indicate viscosity groups for oils that are preferred for these loads and speeds. When ambient temperatures are low the lower viscosity ranges should be used, and when the ambient temperature is high, the higher viscosities should be selected.

"When bearings have to operate in a wide range of temperatures, an oil that has the least changes with change in temperature, i.e., an oil with high viscosity index, should be selected.

"In the great majority of applications pure mineral oils are most satisfactory, but they should, of course, be free from contamination that may cause wear in the bearing, and they should show high resistance to oxidation, gumming, and to deterioration by evaporation of light distillates and they must not cause corrosion of any parts of the bearing during standing or operation.

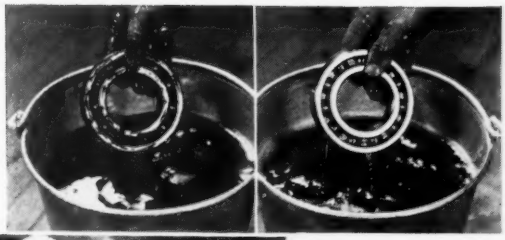
"It is self-evident that for very low starting temperatures an oil must be selected that has sufficiently low pour-point, so that the bearing will not be locked by oil frozen solid.

"In special applications, various componded oils may be preferred, and in such cases the recommendation of the lubricant manufacturer should be obtained."

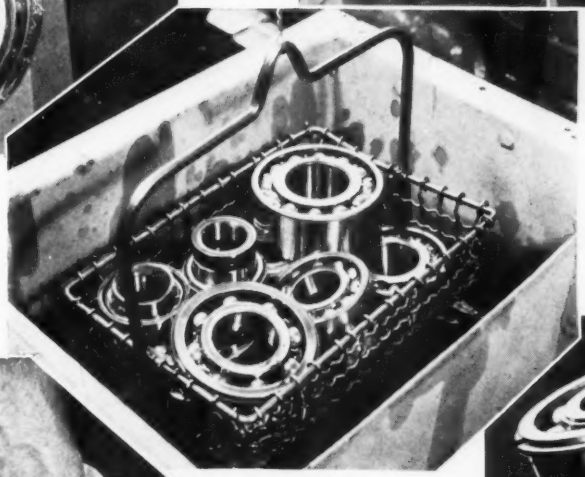
OIL SPRAY OR MIST LUBRICATION

This involves one of the most interesting developments which have accompanied the expansion of the bearing industry. In effect, it came into being with the perfection of the high speed woodworking and machine tool spindle bearing. Oil spray or mist actually involve distinct methods of attainment, though the net result in the end is the same. Mist lubrication usually infers the use of low pressure air and an external lubricator to develop an atomized mist of oil around the bearing parts. Oil spray is usually a function of the design of the bearing it-

For longer storage, coat all surfaces of bearings with a light protective grease. Don't handle more than necessary before greasing.



Soak bearings thoroughly in plenty of solvent. Rinse them in clean solvent, light oil or kerosene.



Better than pail if available. Put in only one layer of bearings. Keep basket off bottom of tank.

Clean hands plus clean rags mean cleaner bearings and less chance of corrosion from perspiration.

Hold clean bearing like this when rotating outer race during inspection.

Oil spray cleaner is desirable and efficient equipment. Use it with a filter in the air line.

After cleaning, put oiled bearings in covered box if to be reused in a short time. Any clean pan or box will serve if tightly covered.

Courtesy of Anti-Friction Bearing Manufacturers Assoc., Inc.

HOW TO HANDLE BEARINGS

self, flingers being provided on a ring or collar which dips into an oil bath, subsequently the oil is broken up into a mist or spray by the rotating action of the bearing itself.

Oil mist lubrication is most effectual in keeping power consumption down, and the parts turning at the required speed without excessive rise in bearing temperatures. A specific example of the successful use of oil mist lubrication is found in high speed grinding in the ball and roller bearing industry itself.

As an alternate to oil mist lubrication, bearings designed for oil can be bath lubricated, pressure fed, or served by drip-feed cups. A bath-oiled bearing which is suitably sealed and charged with oil to a static level which provides immersion of about one-half of the lowest ball or roller, will generally develop the least amount of churning and friction within the oil itself. Pressure-fed bearings usually are fairly well filled with oil, but here the oil is used as a heat transfer agent and such systems are generally applied to slower speed heavy duty bearings as found on paper making machinery. Drip-feed lubrication can be positively controlled and is applicable to high speed service. Research has indicated that a rate of feed of one drop of oil per hour can safely be maintained with markedly low indication of friction. From the research findings of most authorities the following rule can be formulated:

> Keep the oil content in the bearing as low as possible to reduce power losses through churning. Less oil is required as speeds are increased.

CONTROL OF LUBRICANT LEVEL

This can be most positively assured in a grease-lubricated bearing by providing a tight seal and pre-lubrication; this practice prevails in the preparation of aircraft control bearings where a wide range of operating temperatures must be anticipated and where an excess of grease might readily cause sluggish bearing operation at very low temperatures. The amount of grease applied to a prepacked bearing is controlled by use of a power lubricator which can be set to measure the desired amount of grease. Lubrication is carried out on the assembly line after the ball races and retainers have been assembled, just before the seals are fitted.

To attain controlled lubrication of a grease-lubricated ball or roller bearing in service is a far more difficult matter. Also, the extent of the problem depends upon whether or not the bearing can be lubricated while the shaft is turning.

In a running bearing — When grease is applied by pressure gun to a bearing which is in motion, the pressure developed by the gun is to some extent offset by the action of centrifugal force which tends to mould the grease in an evenly distributed layer around the retainer and inner surface of the outer race which is so very often the fixed element. If there is a suitable vent provided either in the form of a removable plug or a special hole in the grease fitting, as soon as the pressure gun pressure exceeds the centrifugal pressure, grease will commence to exude from the vent hole. The distance this hole is located above the centerline of the bearing controls the pressure equalization point and roughly controls the amount of lubricant which can be charged to the bearing when the latter is running. Venting effectually prevents over-lubrication with grease and the resultant possibility of rupture of the bearing seals.

On Idle Machinery — Not all bearings however, can be re-lubricated when running. Some can only be so serviced when the machine is idle. Under such conditions there is no centrifugal force being developed and it is very easy to over-lubricate the bearing, for leakage of grease via the vent (if open) often is only noticed after the bearing has been filled completely with grease. By recording the approximate grease capacity of such bearings and the volume of grease discharged at each stroke of the gun, the amount of grease applied can be better controlled.

Oil Lubricated Bearings — Oil lubricated ball or roller bearings are either individually oiled or served by oil circulated to them via a pressure circulation system or the splash action of other mechanisms such as gearing or reciprocating parts. Any bearing lubricated by splash or oil circulation is generously flooded with oil as a rule. Control of the amount of oil in any specific bearing usually is impracticable.

Unit lubricated bearings served by oil cups or bottle oilers, etc., have their oil level dictated by the level in the oiler. In such bearings it is most practicable to approach the ideal of just enough oil to wet the surfaces without building up an excess which might cause rise in bearing temperatures through internal friction.

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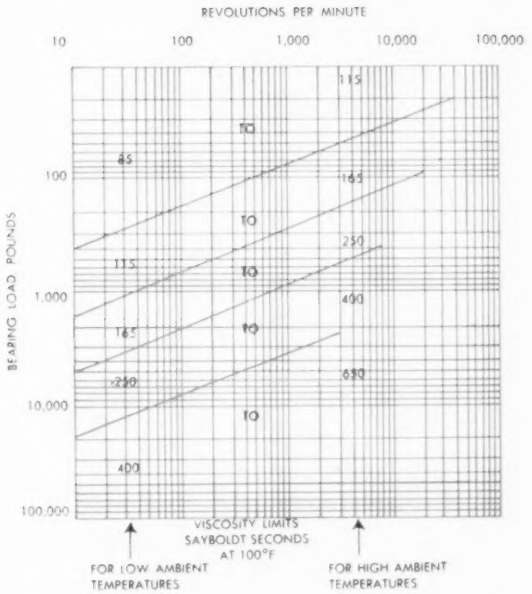
BALL AND ROLLER BEARING LUBRICATION

The ABEC* chart for *oil-lubricated* anti-friction bearings. The purpose of this chart is to enable selection of viscosities of oil for various operating conditions.



Texaco Capella and Ursa Oils conform with the ABEC requirements.

GREASES FOR RELUBRICATION OF BALL BEARINGS

Operating Temp Range	SPEED FACTOR (BEARING BORE IN MM × RPM OF SHAFT)			
	Up to 75,000	75,000 to 150,000	150,000 to 300,000	300,000 to 450,000
	GREASE	GREASE	GREASE	GREASE
−50°F to +125°F	No Recommendation	No Recommendation	No Recommendation	No Recommendation
−10°F to +125°F	ABEC-II*	ABEC-I	ABEC-I	No Recommendation
32°F to 150°F	ABEC-II	ABEC-I	ABEC-I	No Recommendation
60°F to 200°F	ABEC-II	ABEC-I	No Recommendation	No Recommendation
OVER 200°F	No Recommendation	No Recommendation	No Recommendation	No Recommendation

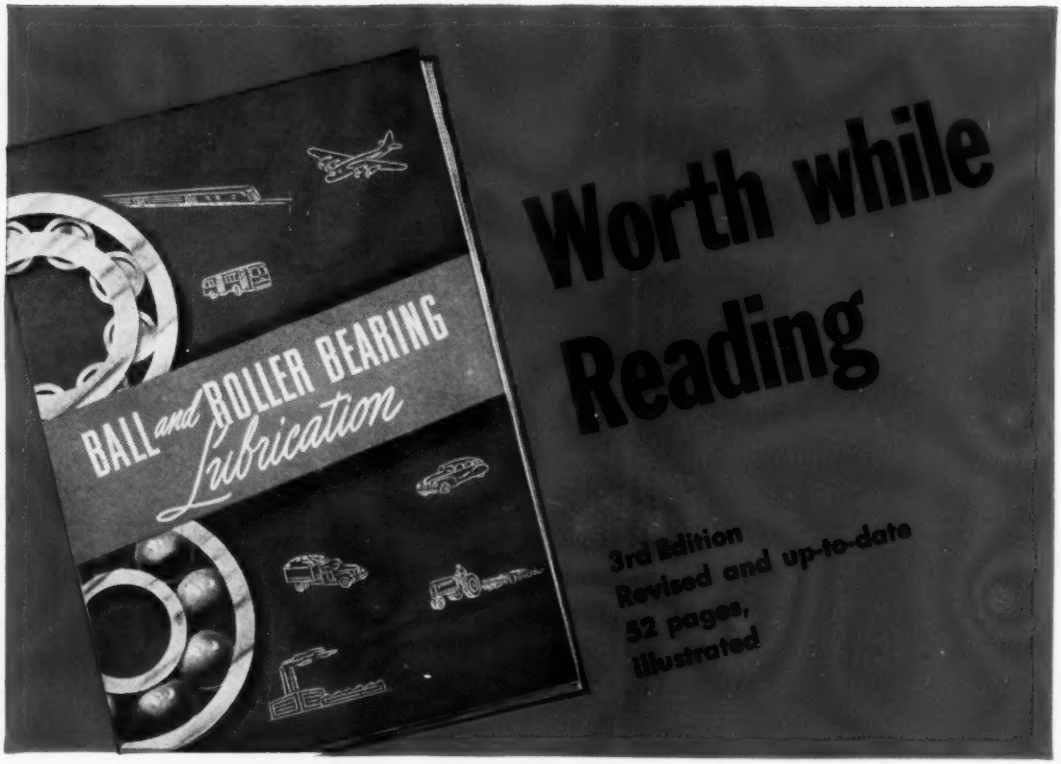
For excessive moisture conditions, a water repellent grease may be required

*ABEC-I may be preferred for some applications.

The properties of Texaco Regal Starfak correspond to the requirements of ABEC Standards and the NLGI Classification.**

*Annular Bearing Engineers Committee
** National Lubricating Grease Institute

THE TEXAS COMPANY



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TO ANYONE whose work has to do with ball or roller bearings, this 52-page book, "BALL AND ROLLER BEARING LUBRICATION", prepared by The Texas Company with the cooperation of the Ball and Roller Bearing Industry will prove both interesting and helpful.

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Application of Lubricants
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